



New locality for *Lepidosiren paradoxa* (Fitzinger, 1837) (Dipnoi: Lepidosirenidae) in Argentina

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Abstract. This study documents a new locality of the lungfish *Lepidosiren paradoxa* on the coast of the Entre Ríos Province in the lower Paraná River. This finding represents the third southern record of this species on southern of South America. Additionally, as this region has been relatively well sampled both during past decades and currently, I discuss possible reasons why this new specimen has been observed only recently.

Key words. South American lungfish; Entre Ríos; Paraná River

Lungfish (Dipnoi) are a unique clade of sarcopterygian fishes, distributed globally (BEMIS 1983; MARSHALL 1987). Currently, dipnoans comprise 6 species (ESCHMEYER 2016) of living air-breathing fishes and several extinct relatives, characterized by the possession of either 1 or 2 lungs. Extant species include the South American *Lepidosiren paradoxa* (FITZINGER 1837), the 4 African species *Protopterus annectens* (OWEN 1839), *P. amphibius* (PETERS 1844), *P. aethiopicus* (HECKEL 1851), and *P. dolloi* (BOULENGER 1900), and the Australian *Neoceratodus forsteri* (KREFFT 1870). Living lungfishes occur only in freshwater rivers, swamps, or lakes, and are physiologically incapable of crossing large expanses of saltwater (BEMIS et al. 2003).

Lepidosiren paradoxa is characterised by 5 gill arches, 4 gill clefts, very elongate body, filamentous pectoral and pelvic fins (without rays), small scales, paired swimbladder (lungs), and larvae with external gills (NELSON et al. 2016). Although this species was described in 1837 and the type locality is the Madeira River, a tributary of the Amazon, its distribution within South America is still poorly known. *Lepidosiren paradoxa* is distributed in the Amazon basin (Brazil, Bolivia, Peru, Colombia, Venezuela and French Guiana), Paraguay Basin (Paraguay, Argentina, Bolivia), and Paraná Basin (Argentina, Brazil and Paraguay) (NELSON et al. 2016). It inhabits the northeast of Argentina, in Salta, Formosa, Corrientes, Chaco, Santa Fe and Buenos Aires Provinces (Fig. 1) (LIOTTA 2006). This report represents the first known record of *L. paradoxa* on the coast of Entre Ríos Province, Argentina.

On August 2016, a living specimen of *L. paradoxa* (Fig. 2)

was caught by a local fisherman in shallow waters (depth of approximately 3 m) in a coastal area of the locality of General Alvear, Entre Ríos Province, Argentina (31°55'27.60" S, 060°39'45.52" W) (Fig. 1). After collection, the specimen was frozen and transported to the laboratory for identification. The specimen was identified according to diagnosis of RINGUELET et al. (1967) then deposited in the Fish Collection of the Laboratorio de Vertebrados, Centro de Investigaciones Científicas y Transferencia de Tecnología a la Producción (CICyTTP-V-18, Diamante, Entre Ríos, Argentina). The description follows the anatomical nomenclature proposed by RINGUELET et al. (1967). Distribution data for Argentina were taken from LIOTTA (2006) and CASCIOTTA et al. (2005). Biological and ecological data were taken from CASCIOTTA et al. (2005).

The specimen (Fig. 2) is characterized by an anguilliform (eel-like), elongated, and rounded body, compressed at its caudal end. It measures 950 mm total length. The head is large and fits about 10 times in the total length. It has a pair of gill open-

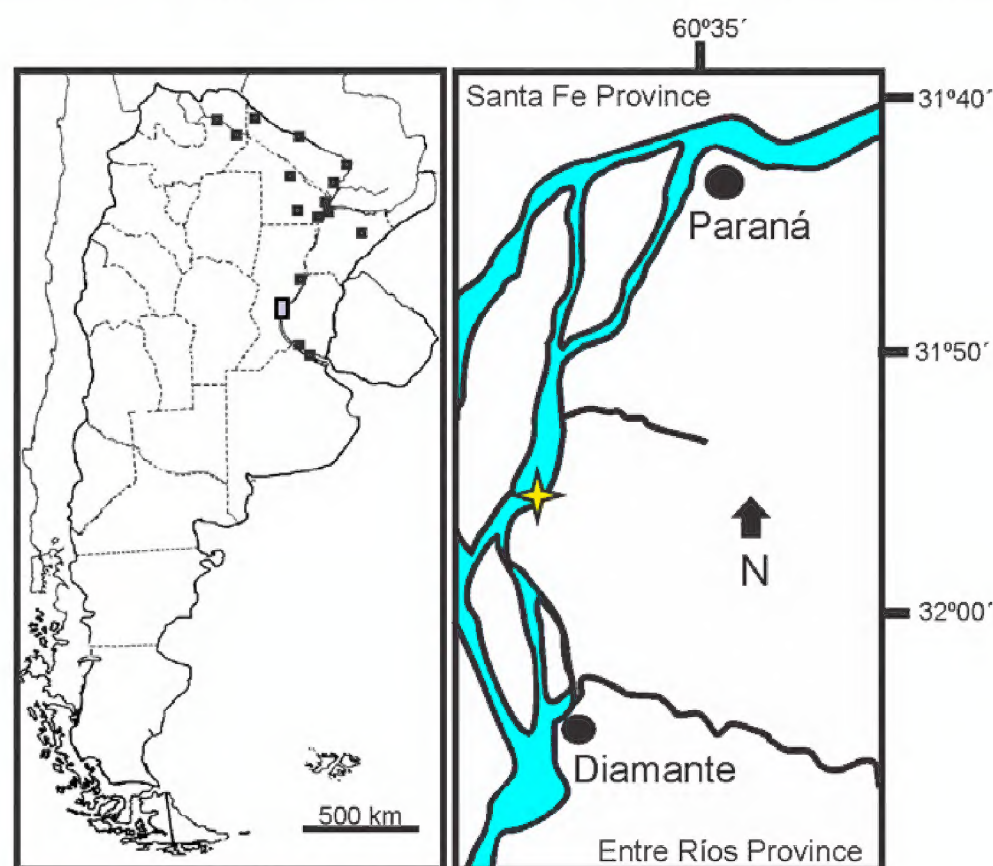


Figure 1. Map of Argentina showing all the records of *Lepidosiren paradoxa* (left). Gray rectangle = amplified area (right); star = new locality in Entre Ríos Province; squares = distribution records extracted from LIOTTA (2006).

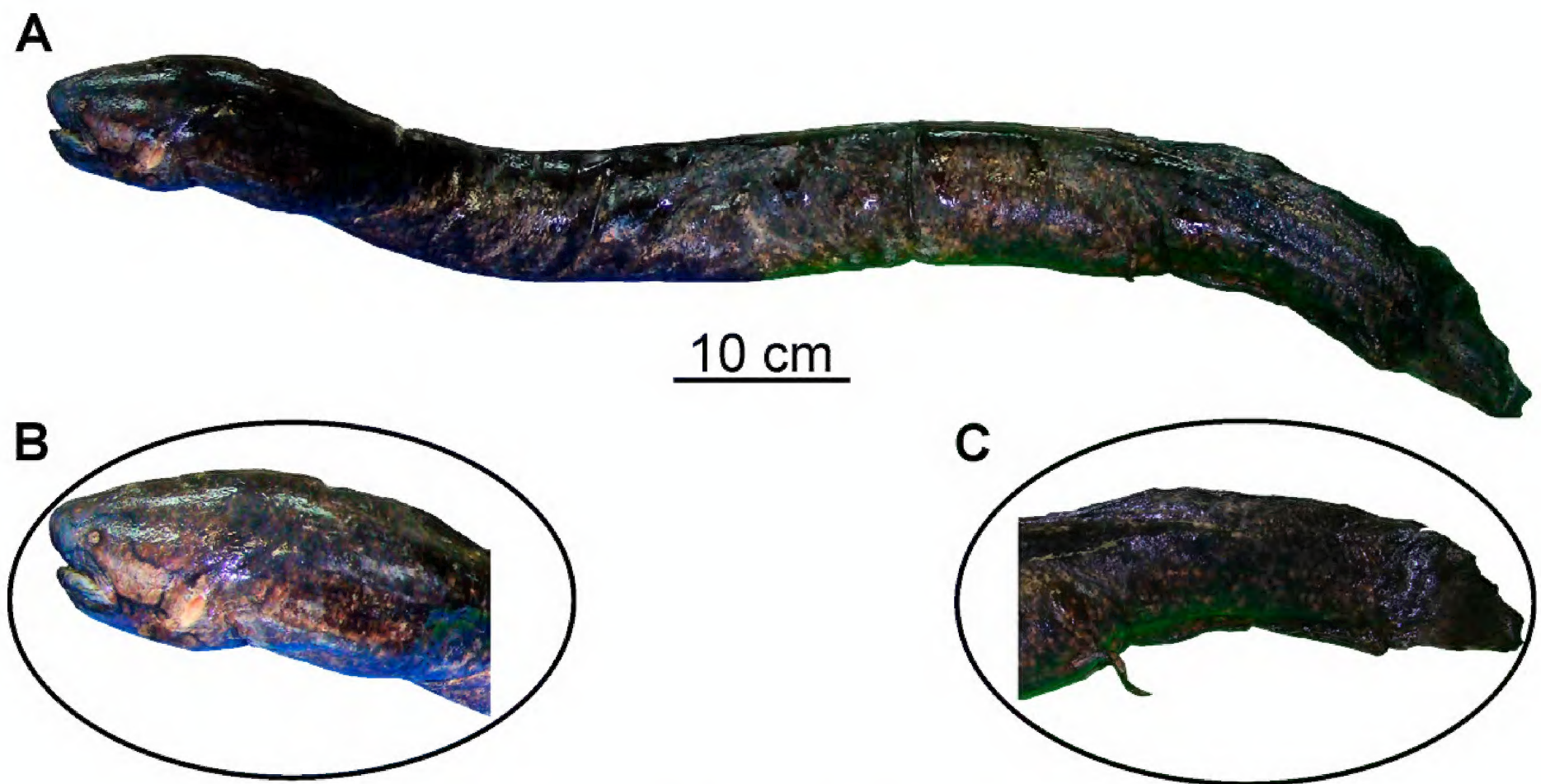


Figure 2. *Lepidosiren paradoxa* (CICyTTP-V-18) [950 mm TL] captured in shallow waters (ca. 3 m) off the lower Paraná River, west coast of Entre Ríos Province, Argentina.

ings on either side that are very small. The mouth is terminal, the snout is roun, and teeth are formed by dental plates. The eyes are small. The pectoral and pelvic fins are filiform. The dorsal fin converges with the caudal and anal fins forming a continuous fold; this begins dorsally in the middle of the body and ends in the abdomen at the level of the pelvic fins. The anus is offset from the sagittal plane. The scales are small and embedded in the skin. The color pattern is uniform black.

These animals are especially interesting because of their characteristic body forms, generally large size, and peculiar mode of life. Adult *Lepidosiren* live as solitary individuals in swamps, or shallow lakes with floating vegetation (KERR 1950). It is most often found where water has a low conductivity (less than 100 $\mu\text{S}/\text{cm}$) with neutral or slightly acidic pH, and temperatures ranging from 24 to 28°C (MENNI 2004). It is a species able to survive drought because it builds a 50 cm deep cavity where it remains buried until conditions improve. During this period, atmospheric oxygen penetrates through the pair of open holes in the top of the shelter, the species' skin secretes a mucus to protect the body, metabolism is reduced, and stored fat in the caudal area is consumed.

Reproduction occurs during the rainy months, when adults move into flooded areas. The eggs are deposited in a nest built in a horizontal cave with a closed bottom that can reach 1.5 m. The males develop filaments known as "pelvic gills" on their pelvic fins and exhibit parental care by protecting eggs and young in the nest (CASCIOtta et al. 2005). The pelvic gills can be induced to be formed by injections of testosterone (URIST 1973) and are believed to release oxygen into the water of the nest to raise its oxygen levels (CUNNINGHAM 1932). External gills are prominent throughout the yolk-sac larval period and are retained in the free-living larval and juvenile stages. These gills are usually resorbed in the seventh week. Juvenile specimens typically have a pattern of bright yellow spots; these spots are lost as the individual grows, with adults achieving a

black or slate-grey color (CASCIOtta et al. 2005).

L. paradoxa has nocturnal habits. It is a predator. It feeds mainly on aquatic invertebrates, like insects, mollusks, and crustaceans that inhabit the bottom of rivers, as well as small fish. Juveniles feed on insect larvae and snails (CASCIOtta et al. 2005).

This record includes a new locality in Argentina. It is the first confirmed sighting of this species in Entre Ríos Province and the third for the lower Paraná River. Previously, MACDONAGH (1945) and GIACOSA & LIOTTA (1997) collected other individuals at the Paraná River delta (Table 1). Therefore, the historical records indicate that the presence of *L. paradoxa* in the delta is sporadic and that the southernmost known locality is San Pedro, in Buenos Aires Province (33°50' S) (Fig. 1).

An interesting observation is that the lungfish which inhabit the Amazonian basin differ from those in the Paraguay basin. For example, occasionally in the Gran Chaco, the habitat dries out almost completely during the dry season. Instead, in Amazonia, the water retreats following seasonal flooding so that the fish can move with the water level from seasonally flooded forests back into permanent channels (COX FERNANDES 1997). An explanation of the finding of *L. paradoxa* in Entre Ríos province might be the great flood that occurred in 2016 in the Paraná River basin. This kind of event creates connections between different environments through waterlogging. Thus, it is possible that this flood event caused the species to be found several kilometers from its more frequent distribution range. This new record for *L. paradoxa* only reinforces the need to spend more research effort on different regions of the Paraná River in order to learn about and preserve the fish fauna belonging to one of the world's largest floodplains.

Moreover, *L. paradoxa* is one of the ornamental fish of the Argentine fluvial coast that are subject of marketing without clear regulations or controls (GÓMEZ et al. 1994). Considering this is a unique lungfish in South America, and is highly

Table 1. Detail of the records of *Lepidosiren paradoxa* in Argentina (modified from LIOTTA 2006).

Locality	Province	Basin	Reference
Isleta	Formosa	Pilcomayo River	BARRIO 1943
San Pedro	Buenos Aires	Paraná River?	MACDONAGH 1945
?	Corrientes	Esteros del Iberá	RINGUELET et al. 1967
Bañado del río Corriente	Corrientes	Esteros del Iberá	CASCIOTTA et al.2005
Resistencia	Chaco	Paraná River	RINGUELET et al. 1967
Clorinda	Formosa	Paraguay River	RINGUELET et. al. 1967
Hickmann	Salta	Paso de las Conchas	RINGUELET et. al. 1967
?	Corrientes	Riachuelo Stream	BONETTO et al. 1978
San Javier	Santa Fe	Paraná River	DEL BARCO 1982
?	Chaco	Bermejo River	MARTÍNEZ 1983
?	Salta	Bermejo River	ARRATIA et al. 1983
?	Chaco	Paraguay River	MARTÍNEZ 1983
?	Chaco	Paraná River	MARTÍNEZ 1983
?	Chaco	marshes and lagoons	MARTÍNEZ 1983
Vaca Perdida	Formosa	?	MENNI et al. 1992
Formosa	Formosa	tributary of Paraguay River	MENNI et al.1992
San Nicolás	Buenos Aires	Yaguarón Stream	GIACOSA & LIOTTA 1997
General Alvear	Entre Ríos	Paraná River	This study

vulnerable due to extraction of natural populations without control (although it is not on the list of endangered species), it is important to improve knowledge of this species to inform possible measures of preservation.

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LITERATURE CITED

ARRATIA, G., PEÑAFORT, M.B. & MENU-MARQUE, S. 1983. Peces de la región sureste de los Andes y sus probables relaciones biogeográficas actuales. *Desert* 7: 48–107.

BARRIO, A. 1943. Observaciones sobre *Lepidosiren paradoxa* y fijación del material argentino. *Revista Argentina de Zoogeografía* 3: 9–20.

BEMIS, W.E. 1983. Studies on the evolutionary morphology of lepidosirenid lungfish (Pisces: Dipnoi) [PhD dissertation]. Berkeley, University of California. 331 pp.

BEMIS, W.E., COX FERNANDES, C. , CORREA E CASTRO, R., ZUANON, J., RAPP PY-DANIEL, L., ALVES-GOMES, J., MENDES DOS SANTOS, G., MACHADO, F.A. & MALABARBA, L.R. 2003. Notes on the systematics, distribution and natural history of the South American Lungfishes in the genus *Lepidosiren* Fitzinger 1837 (Dipnoi: Lepidosirenidae). Accessed at http://www.bio.umass.edu/biology/bemis/Lungfish_ms.pdf, December 2016

BONETTO, A.A., ROLDÁN, D. & OLIVER, M.E. 1978. Estudios limnológicos de la cuenca del Riachuelo (Corrientes, Argentina). I. Poblaciones de peces en ambientes leníticos y lóticos. *Ecosur* 9: 1–15.

BOULENGER, G.A. 1900. List of the fishes collected by Mr. J.S. Budgett in the River Gambia. *Proceedings of the Zoological Society of London* 1900: 511–516.

CASCIOTTA, J., ALMIRÓN, A. & BECHARA, J. 2005. Peces del Iberá. Hábitat y Diversidad. La Plata. 244 pp.

COX FERNANDES, C. 1997. Lateral migrations of fishes in Amazon floodplains. *Ecology of Freshwater Fish* 6: 36–44. <https://doi.org/10.1111/j.1600-0633.1997.tb00140.x>

CUNNINGHAM, J.T. 1932. Experiments on the interchange of oxygen

and carbon dioxide between the skin of *Lepidosiren* and the surrounding water, and the probable emission of oxygen by the male *Synbranchus*. *Proceedings of the Zoological Society of London* 1932: 875–887. <https://doi.org/10.1111/j.1096-3642.1932.tb01569.x>

DEL BARCO, D. 1982. Peces de la provincia de Santa Fe. Algunos peces poco conocidos de nuestra provincia. 1. *Lepidosirena*, pez pulmonado (*Lepidosiren paradoxa* Fitzinger, 1837). *Cyta, Ministerio de Agricultura y Ganadería, Santa Fe* 28: 38–40.

ESCHMEYER, W.N., & FRIKLE, R. [2016]. Catalog of fishes: genera, species, references. Accessed at <http://researcharchive.calacademy.org/research/ichthyology/catalog/fishcatmain.asp>, 1 November 2016.

FITZINGER, L.J.F.J. 1837. Vorläufiger Bericht über eine höchst interessante Entdeckung Dr. Natterer in Brasil. *Isis* 30: 379–380.

GIACOSA, B.R., & LIOTTA, J.R. 1997. Nuevo hallazgo de *Lepidosiren paradoxa* Fitzinger, 1837 (Sarcopterygii: Lepidosirenidae) en el Delta del Río Paraná (San Nicolás, Buenos Aires). *Natura Neotropicalis* 28: 147.

GÓMEZ, S.E., CASSARÁ, H., & BORDONE, S. 1994. Producción y comercialización de los peces ornamentales en la República Argentina. *Revista de Ictiología* 2/3: 13–20.

HECKEL, J.J. 1851. Über eine neue Fisch-species aus dem Weissen Nil, *Protopterus aethiopicus*. *Sitzungsberichte der Mathematisch-naturwissenschaftlichen Classe der Kaiserlichen Akademie der Wissenschaften* 7: 685–689.

KERR, J.G. 1950. A naturalist in the Gran Chaco. *Lepidosiren Expedition*. Cambridge University Press, Cambridge, UK. pp. 169–229.

KREFFT, G. 1870. Description of a gigantic amphibian allied to the genus *Lepidosiren* from the Wide-Bay district, Queensland. *Proceedings of the Scientific Meetings of the Zoological Society of London* 1870: 221–224.

LIOTTA, J. 2006. Distribución geográfica de los peces de agua continentales de la Argentina. Serie Documentos 3, ProBiotá. Buenos Aires. 701 pp.

MARSHALL, C.R. 1987. Lungfish: phylogeny and parsimony; pp. 151–162, in: BEMIS, W.E., BURGGREN, W.W. & KEMP, N.E. (eds.). *The biology and evolution of lungfishes*. New York.

MACDONAGH, E. 1945. Pesca de una carpa espejuelo en el Río de la Plata. *Nota Museo de La Plata* 89: 315–324.

MARTÍNEZ, E. 1983. Peces, en: *Flora y fauna de la provincia de Chaco*. Fuerza Aérea Argentina, Cdo. Reg. Aéreas, Reg. Aérea Noreste, 1 lámina.

MENNI, R.C., MIQUELARENA, A.M., LÓPEZ, H.L., CASCIOTTA, J.R.,

- ALMIRÓN, A.E., & PROTOGINO, L. 1992. Fish fauna and environments of the Pilcomayo-Paraguay basins in Formosa, Argentina. *Hydrobiologia* 245: 129–146. <https://doi.org/10.1007/BF00006154>
- MENNI, R.C. 2004. Peces y ambientes en la Argentina continental. *Monografías del Museo Argentino de Ciencias Naturales* 5: 1–316.
- NELSON, J.S., GRANDE, T.C., & WILSON, M.V.H. 2016. *Fishes of the world*, 5th edition. Hoboken: John Wiley & Sons. 707 pp.
- OWEN, R. 1839. A new species of the genus *Lepidosiren*. *Proceedings of the Linnaean Society of London* 1: 27–32.
- PETERS, W.C.H. 1844. Über einen dem *Lepidosiren annectens* verwandten, mit Lungen und Kiemen zugleich versehenen Fisch aus den Sümpfen von Quellimane vor. Bericht über die zur Bekanntmachung geeigneten Verhandlungen der Königlich Preußischen Akademie der Wissenschaften zu Berlin 1844: 411–414.
- RINGUELET, R.A., ARÁMBURU, R., & ARÁMBURU, A.A. 1967. Los peces argentinos de agua dulce. Comisión de Investigación Científica. La Plata. 602 pp.
- URIST, M.R. 1973. Testosterone-induced development of limb gills of the lungfish, *Lepidosiren paradoxa*. *Comparative Biochemistry and Physiology* 44: 131–135. doi: [https://doi.org/10.1016/0300-9629\(73\)90376-9](https://doi.org/10.1016/0300-9629(73)90376-9)

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